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The Correlation Between Music and Math

Caroline T. Mallory
Worcester Polytechnic Institute

The Effect of Music on Math and Science Standardized Test Scores

An Interactive Qualifying Project Proposal
Submitted to the Faculty of
Worcester Polytechnic Institute
in partial fulfillment of the requirements for the
degree of Bachelor of Science

By
Caroline Mallory

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Report Submitted to:

Professor John Delorey
Worcester Polytechnic Institute

Abstract

The goal of this project was to collect and review existing data on the relationship between involvement in music and higher standardized test scores in math and science. Using this data to show the benefits of music involvement, an argument for keeping or increasing funding for music programs in schools in St. Croix of the U.S. Virgin Islands is made. Additionally a survey to assess the relationship in students on island has been constructed. Suggestions for how to conduct the survey and distribution are included.

Authorship Page

This project has been the work solely of Caroline Mallory.

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Introduction

Everyone has heard that listening to Mozart makes you smarter. That is not correct. However, research has shown that listening to Mozart, playing an instrument or participating in a chorus over a long period of time can increase spatial temporal reasoning that can lead to better performance in math and science. Evidence from the 1990's shows that listening to Mozart changes the way the brain processes information, and continuing research into the subject has investigated why and how. Additionally, other studies explore the relationship between involvement in music and standardized test scores in high school students.

The importance of this relationship in students' and teens' development is something to be further researched and demands action on the part of schools and guardians. If a child's development in math and science can be augmented or encouraged through involvement in music, then educators should take this to heart. However, in most school districts, when funding is cut, one of the first programs to have their budget reduced is the art department. Based on the following information, school supervisors should be encouraged to re-think their arts department.

Background

Historical Data

Investigation into the correlation between music and math began during the mid-twentieth century. Since then, numerous tests and experiments have been designed and performed to explore this hypothesis. The different inquiries into this correlation usually fall into one of two schools of thought; attributing the correlation either how brain function is altered by music or by external factors of being involved in music. This project includes information from reports from the following two groupings of information on this topic. One looks at how the brain reacts to musical stimulation versus silence, a meditative state, random noise, etc. The other examines student's standardized test scores and the information they voluntarily supply at the end in regards to involvement in a number of extracurricular activities, such as music. This data was then compared with the socioeconomic stance, racial mix and other factors in the school district. These two categories provide a wealth of information on how listening and being actively involved in music can affect children and teens cognitive function as evidenced by standardized test scores.

The connection between these two seemingly different subjects is spatial-temporal reasoning that shows up in the patterns repeated in a piece of music or a group of numbers. The presence of patterns and numbers, repetitions and fractions in music are all tangible examples of similarities with mathematics. Additionally, the brain processes music and math in the cerebellum. The increased activity in the brain from listening to music prior to performing some spatial activity, pattern recognition or spatial analysis is improved in a statistically significant way from relaxation.

Theories and Experiments

There are many theories about why; the first published being the Mozart Effect. Dr. Alfred A. Tomatis postulated this effect in 1991 when he wrote "Pourquoi Mozart?" (Why Mozart?). Dr. Tomatis, a researcher and practicing doctor, had been using music, Mozart in particular, to heal his patients by "retraining" the ear. He mostly treated patients who had speech defects or disabilities. In 1993, Raucher, Shaw, and Ky performed an experiment specifically looking into the effect listening to Mozart had on spatial reasoning. The results showed an improvement in their subjects as measured by an IQ test. The results became popular when the results were misinterpreted as showing an improvement in IQ because of listening to classical music. However, since those results were unable to be reproduced, many of the initial assumptions surrounding that finding have been re-evaluated and the emerging theory is that listening to classical music, specifically Mozart increases spatial- temporal reasoning temporarily. The effect of stimulating the same part of the brain that is used to listen to music and in spatial reasoning creates an environment of readiness and alertness for those tasks that use the brain in that way. There have been experiments to explore this theory. These experiments attempt to explain why and how listening and being involved in the production of music can improve mathematical reasoning or spatial and cognitive function as relates to mathematics.

The other set of experiments investigated look more at the effect of involvement in a music class or playing a musical instrument on High Schooler's performance on standardized testing. Through statistical analysis of SAT scores from the years 1987 through 1998, a correlation between time involved in music classes and increased verbal and math scores was noted. Between zero and three years of music classes in high school showed a linear improvement in math and verbal scores. At four years of involvement in music, though, there

was a marked increase in both math and verbal scores. These results show, but don't explain how, involvement in music, whether through singing or playing an instrument over a long period of time increases student's abilities in math.

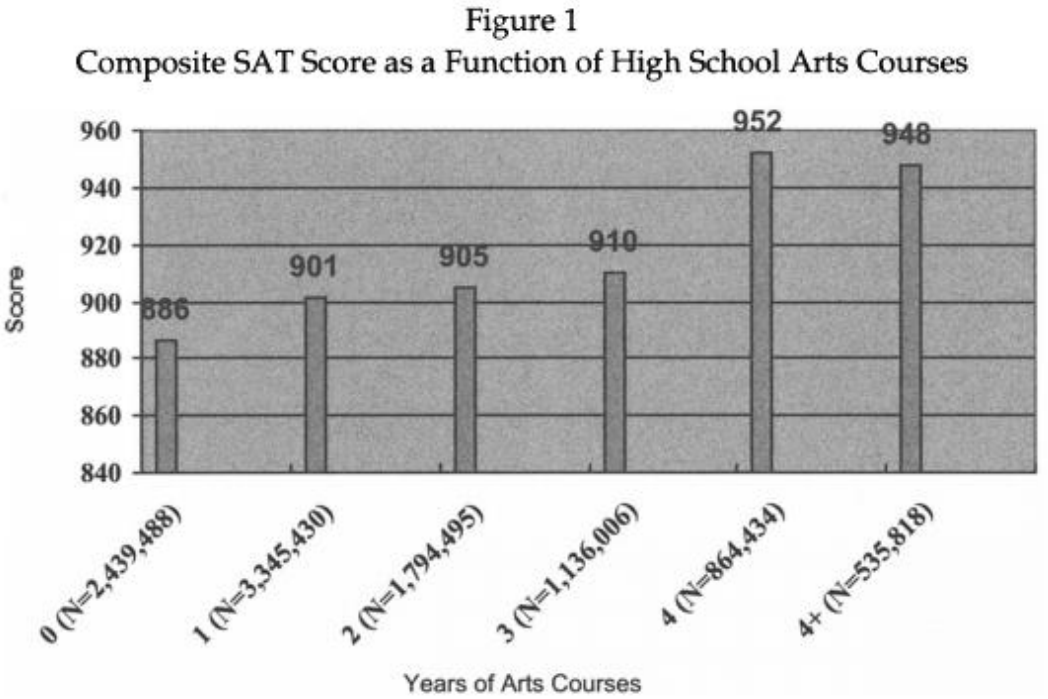

Figure 1: Composite SAT Score as a function of High School Arts Courses

As shown in Figure 1, there is a steady increase in overall score as the number of years in arts courses increases up until year four, at which point there is a large jump, and stabilization after that point.

Figure 2

Math SAT Score as a Function of High School Arts Courses

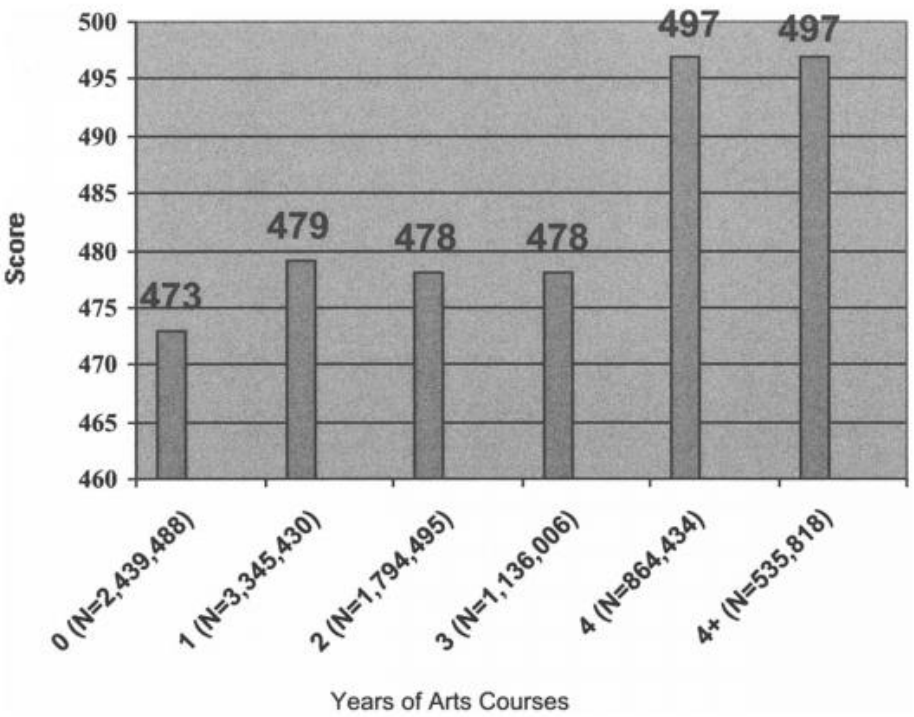

Figure 2: Math SAT Score as a Function of High School Arts Courses

As shown in Figure 2, Math scores of those students involved in the arts at all have a higher score than those who didn't at all, and those who participate for four years or more have a much higher score than those who are involved for less time. This data suggests that any involvement in arts at all is a benefit to the participants, and prolonged exposure and interaction with the arts increases mental capabilities specifically in regards to math.

Methodology

Research Begun

The beginning of this project involved gathering resources to be fully read and used at a later date. This started by going to the library and meeting with a librarian to discuss available online and interlibrary resources. A search criterion was then formed to gather data about the subject. The criteria involved the keywords "math", "science", "music", and "education". These were used to search educational and peer –reviewed journals that WPI students have access to through Gordon Library's website. The main resource used was JSTOR®, the online database of academic journals. Within this catalog, keyword searches were conducted and the resulting data further sifted through analysis of relevance to the project at hand. A list of articles that could be helpful was then compiled as a reference for further reading.

Project at Hand

With the research underway, the next step is to find the data having to do with music and how it relates to performance on standardized testing. A few articles found deal directly with how music and long term (long term being defined for this study's purpose as 4 or more years) involvement in music affect standardized test scores and specifically math and science. Data and graphs from these articles are in Appendix A.

The studies found during research can be used as an example to create a baseline for a study in the Virgin Islands. Due to the difficulty of creating a test that accurately assesses the ability of all students in math and science as well as their involvement in music, the SAT test is used as an ideal. It gages the ability of students in a standardized way, as well as provides students and opportunity to voluntarily provide information about involvement in extracurricular activities. This means that they would have no reason to lie about it, thus removing any bias

from the data. The SAT data is accessible through CollegeBoard, the organization that creates and scores the SAT. To get the data for the Virgin Islands, one would have to fill out a Data Release Form, shown in Appendix A. Similarly, a Copyright and Trademark Permission Request form would need to be filled out to use CollegeBoard data in any published document. This form will also be shown in Appendix A. Additionally, to get the data for a specific region, a written request should be filled out as specified on the CollegeBoard website. Once the data is in hand, certain statistical analysis could be performed to discover any relation between involvement in music, math, and science test scores. The collected data and pursuant analysis can be used when deciding further action.

Survey – Construction and Distribution

A survey could be constructed to supplement or replace the SAT data, alternatively. Surveys are useful tools for passive data collection from a group of subjects. Data is collected from a large population more quickly and uniformly in this way. Other data collection methods, such as interviews or experiments are more time consuming and involved. In this project, a survey was used to gather data about long term involvement in arts and standardized test scores. A sample survey can be found in Appendix A. Through designing a survey, the data collected can be much more controlled and focused, as well as tailored to the target population. However, when constructing a survey, care must be taken to not introduce bias through the questions. Similarly, there must be a large enough number of questions such that the scores in each section – math and science –are an accurate representation of the possible knowledge of the student. Only if these things were taken under consideration would a survey be an adequate substitute for using the SAT data.

After a survey was constructed, the distribution to schools in the district could be done over a period determined at the convenience of the school and the time available in the area. The factors affecting this could be local and national holidays, seasonal breaks, teacher's preference, or the schedule of the researcher, among others. To facilitate rapid or efficient distribution, a list of the high schools in the area should be compiled along with their locations so driving time can be minimized. Suggestions for distribution include breaking up the area into geographical sections and distributing surveys by geographical area in the morning and collecting in the afternoon Collecting the surveys should be done as soon as possible so data analysis can begin quickly, as this will take time. Another distribution system could be surveys distributed to the entire region over the course of an entire day, using the list of schools by location to make the distribution orderly. Over the course of a second day the surveys would be collected.

Data Analysis

Once the surveys are collected, the answers should be assimilated into a single document in a processor such as Microsoft Excel in order to make the data readily accessible. Statistical analysis in a program such as Statistical Analysis System (SAS) or R statistical programming packages will show if the data gathered follows the trend shown in previous studies. Additional analysis of the data or questions to ask will be up to the researcher after initial conclusions are drawn. If the data follows previous trends, what kinds of music programs are instituted in the area that encourages participation? What arts programs need to be improved upon? Conversely, why does the data disagree with previous studies? What other factors are at play in the community?

Results

From this data, it can be concluded that there is some positive relationship between long term involvement in music and increased math scores on standardized testing. There are many theories as to why and what effect listening to music has that it can affect ability in these disciplines. The stimulation of multiple parts of the brain after learning or practicing music is thought to correlate where the spatial –temporal reasoning important to math reside, possibly explaining increased ability in that area. Another possible explanation could be that music, when listened to before performing certain cognitive tasks, 'primes' the brain as opposed to silence or calming music, as it engages different parts of the brain, some of which are used for those functions. Additionally, there could be external factors contributing to how long term involvement in music improves standardized test scores. Some examples could be personality factors of the individuals, increased socioeconomic status of those involved in music long term as opposed to those not involved, or increased parental or guardian involvement in the development of the child.

All these factors contribute to the result that the brain reacts to long term exposure to music, especially Mozart, in such a way that it processes mathematical information in a more efficient or accessible way. This conclusion can and has been statistically tested and proved. However, this information is often disregarded by schools and educators when it comes time to divide up the budget, especially when funding is low. Cutting the funding for arts, especially band and chorus, is a problem that affects not only the horizons of the students, but the potential they could achieve.

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Appendix A

List of Tables and Figures

Figure 1

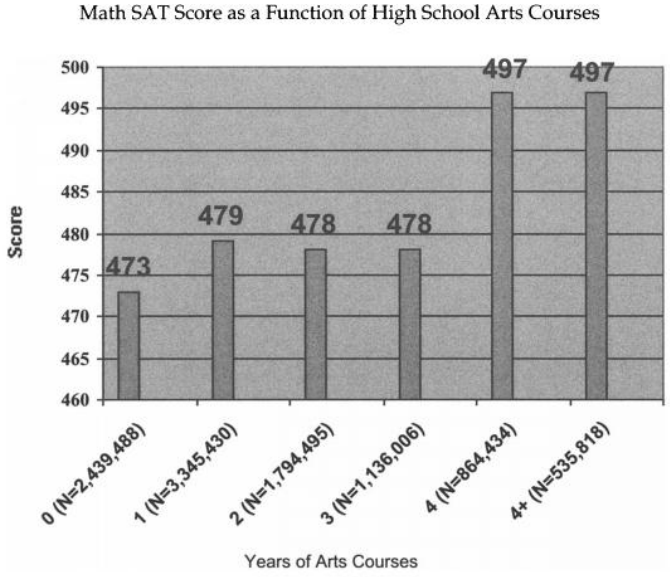
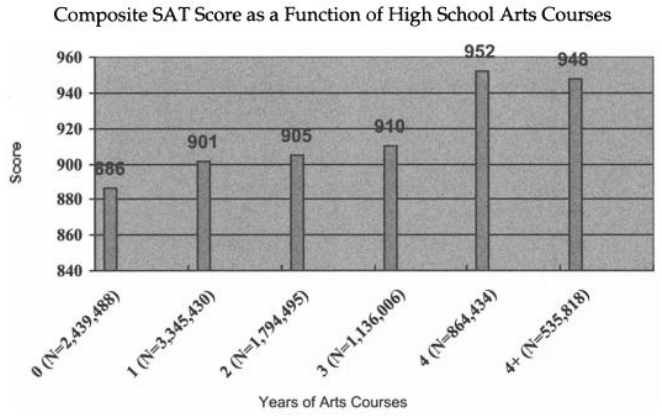


Figure 2



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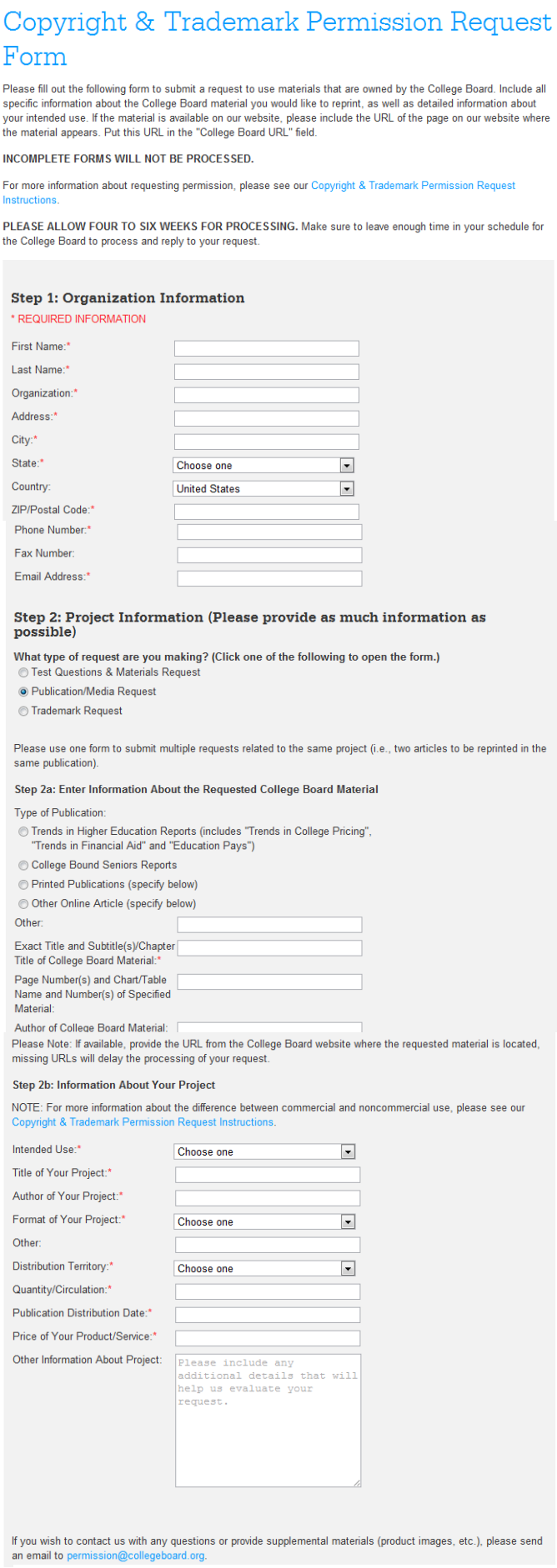

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Format of Your Project:* Choose one
Other:
Distribution Territory:* Choose one
Quantity/Circulation:*
Publication Distribution Date:*
Price of Your Product/Service:*
Other Information About Project: Please include any additional details that will help us evaluate your request.

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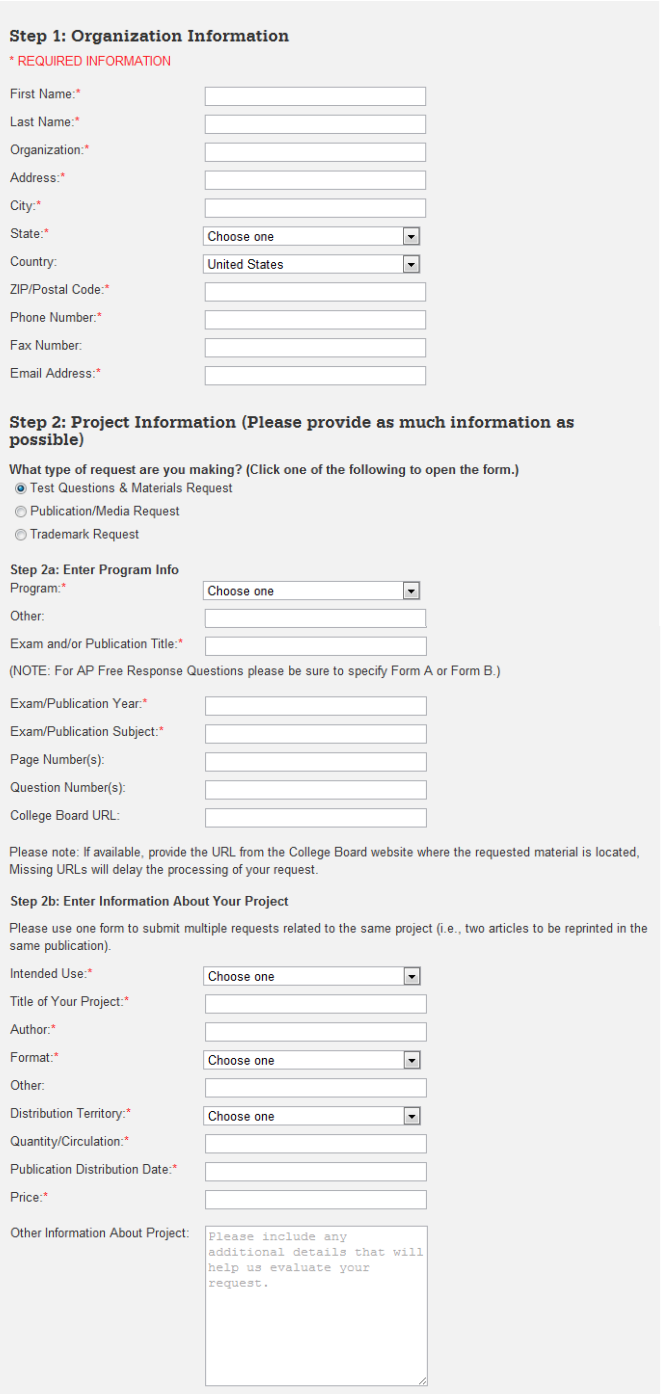
Figure 3: Copyright and Trademark permission Request Form

Test Questions and Materials Request Form from CollegeBoard.com for the request for data from past years for analysis.



Step 1: Organization Information

* REQUIRED INFORMATION

First Name:*
Last Name:*
Organization:*
Address:*
City:*
State:* Choose one
Country: United States
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Phone Number:*
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Step 2: Project Information (Please provide as much information as possible)

What type of request are you making? (Click one of the following to open the form.)

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Other:
Exam and/or Publication Title:*

(NOTE: For AP Free Response Questions please be sure to specify Form A or Form B.)

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Publication Distribution Date:*
Price:*
Other Information About Project: Please include any additional details that will help us evaluate your request.

Figure 4: Test Questions and Materials Request Form

Appendix B

Survey

1. Circle your year in High School.

Freshman Sophomore Junior Senior

2. Are you involved in any of the following extracurricular activities? Check all that apply.

____ Sports ____ Art

____ Band/Orchestra ____ None

____ Chorus ____ Other _____

3. If you checked band, chorus, or art above, please check the number of years involved in that activity.

____ 1 ____ 4

____ 2 ____ 5 or more

____ 3

4. Have you taken the SAT or ACT or other standardized test in the past year?

Yes No

5. If yes, please write your score and the name of the test. _____

6. If the test was SAT or ACT, please write the individual subject test scores here as applicable.

Math _____

Verbal _____

Writing _____

Science _____

Appendix C

Project Proposal

Abstract

This project would collect and analyze the GPA and specific class grades of high school students with special attention to whether the student had participated in a music class or played a musical instrument to discover if there is a relationship between involvement in music classes and higher grades in specific classes or overall.

Introduction

Studies show that babies and toddlers who listen to music, specifically classical, while young typically grow up and have a higher success rate in school. I would like to look specifically at the effect that participating in creating music has on the success of children later in life. By collecting the data of grade point average (GPA) of high school students, specific grades in math, science, and humanities classes, as well as whether the student participates in, or has participated in a music class or has played a musical instrument I hope to discover a correlation between higher GPA and long term participation in music. Referencing national GPA's and grades in specific classes, I hope to establish averages that can be compared to the GPA's of students who do and don't take part in music classes. Additionally, studies evaluating the effect of music on the human brain will be used to explain any correlation discovered. The hypothesis I hope to examine is whether participation in music classes or playing a musical instrument has a positive or negative effect on a student's GPA, and specifically on grades in math and science. When the project is complete, I hope to return to the schools data was gathered from to present my findings, to help them in the way their curriculum is created.

Background

Previous research into the area of correlation between involvement in music and high school GPA's exists, but typically looks at the relation of music and math, specifically. My project would look at the overall relationship between music an academic success. In order to complete this project, I would need to understand and utilize statistical analysis of data for finding mean, standard deviation, Z –scores of the data found. In addition I would need to be able to interpret the data once analyzed, in order to understand any correlation found in the data.

Procedure

To begin this study, the effect of music on the human brain will need to be studied to get a background on the way music affects the brain. Additionally, data for national GPA's and grades

will need to be gathered. Schools in a district will have to be petitioned to allow the surveys to take place, and the data of students to be released to a third party. Survey questions will have to be created with careful attention to how questions are worded, that the questions are not confusing or could be misinterpreted, as the data would be corrupt in that case. After the surveys are collected the data will need to be scrutinized using statistical analysis for any correlations between grades and participation in music classes, or any other relationship that might emerge. This process should take place from the beginning of B Term through the end of C Term of the 2011-2012 school year, using the time of the Christmas break to distribute surveys and collect data.

Bibliography

Music and Mathematics: Modest Support for the Oft-Claimed Relationship
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